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ABSTRACT

In light of the increasing demand for well-prepared chemical technicians, this paper provides suggestions for two-year colleges interested in initiating or upgrading a chemical technology program. Introductory comments indicate that, from the industry standpoint, chemical technicians are invaluable, but inadequate in numbers and often unprepared. Next, a brief history of the development of technician training programs in the United States is presented, emphasizing events that have influenced educational directions. The paper then outlines steps for the development of a chemical technology program, arguing that the program can best be maintained by a faculty member designated as the Coordinator of Chemical Technology, who takes responsibility for recruiting students, developing procedures for academic advisement, instituting an advisory committee, interacting with the department chair, coordinating curriculum activities, and developing student job placement services. Next, the paper provides information on the chemical technology curriculum, emphasizing that while the curriculum is geared toward immediate employment the option of further education should always be open to all students. Finally, the plans of the American Chemical Society for developing a certification/approval process for chemical technology programs are discussed. Appendices illustrate various aspects of the curriculum, texts, courses, career options, and curriculum tracks related to the chemical technology program. (LAL)

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ESTABLISHING CHEMICAL TECHNOLOGY PROGRAMS

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Paper presented at the 85th Annual Conference of the
Committee on Chemistry in the Two-Year Colleges
San Diego, California
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JC 840 554

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In an address given at a regional ACS meeting, Dr. R. F. Kayser, Director of R & D for Union Carbide Corporation said, "When we recognize the portions of the world's development attributable to chemists, we must also recognize the contributions of the technicians who assisted them in developing new products, or processes." He also said the role of the chemical technician is as changeable as the industry itself.

On the other hand, Alan McClelland in addressing the question of "Careers in Chemistry" struck hard at the unpreparedness and diminishing numbers of those at the entry level to the chemical industry. In fact, the two comments underline industries concerns; first that technicians are invaluable and secondly that those that they see at the entry level into the laboratories are generally not well prepared. Paramount to it all, the numbers are exceedingly low. (The industry projects needs in the thousands and the colleges graduate approximately 300 per annum.)

There are four major sources of chemical technicians, they are:

- The high school drop-out or graduate. (may or may not have a course in H.S. chemistry)
- The 4-year college drop-out or graduate. (These people may have taken a chemistry course while pursuing a degree in biology or some related science area. There are some situations where they drop out from B.S. in chemistry and opt to work as a technician. These types in some instances perform well as technicians.)
- The industry has always maintained in-house training programs. Mainly for the people just described among others.
- The two-year college (and other technical institutes, both public and private, plus a smattering of 4-year institutions) must be described as being the viable source of trained and liberally educated chemical technicians.

Before delving into the establishment of a chemical technician program, I'd like to extend a brief historical development of technician training programs in the United States.

(Fig. 1)

As machinery was invented during the late 1700's and into the early to mid 1800's we saw the beginning of the industrial revolution. This precipitated the need for skilled personnel in the manufacturing and maintainance of sophisticated machines and soon to come instruments. So during the 1840's training porgrams began in the northeastern part of the nation such as the one at Lowell Textile (now the U. of Lowell).

The first world war brought about the establishment of training sites for U.S. Army technical personnel. Schools such as, The Ohio Mechanics Institute met those demands and beyond. These institutes supplied a few technicians to the then growing chemical industry in the United States, but most of the personnel (other than scientists) working in the laboratories were trained in-house by other technicians and chemists.

Of course the second world war spured the industry on to a great amount of manufacturing, research and development. The demand for highly skilled laboratory personnel increased proportionally. Two year institutes and colleges began instituting chemical technology programs, but the numbers of interested applicants to these programs was low. (Approximately 10 entering freshmen/program and 4 - 5 continuing sophomores/program.) Again, the industry was the main source of technicians.

From 1962 through 1972 four important events influenced the growth and what I consider the professionalization of chemical technology programs.

- The 1962 vocational technical education act (poured millions into high schools and post high school technical institutions).
- The 1964 Young Committee (ACS) developed a set of curriculum materials to be (basically transfer chemistry) used in technician training.
- The 1966 Roberts Committee reconstructed the Young recommendations and considered the chemistry core for two-year chemical technician programs. (The recommendation of these two committees found limited success.)

'Finally in 1970-1972, a major grant was received by the ACS to establish a technician training program including curricula materials. This was undertaken at U.C. Berkeley under the directorship of Robert Pecsok and Kenneth Chapman. The writings were accomplished by twenty seven chemistry educators.

(Fig. 2)

From these efforts came the Chem TeC curricular materials in 10 volumes. These original ten volumes have since been rewritten and are now available in a second edition format. (ACS distribution.) The materials are the only ones that I know of that cover a complete two-year sequence of academic study (with lecture and laboratory materials) in the education of a chemical technician.

These above mentioned events spurred the academic community on to creating a number of programs nationwide. (Approximately 200 institutions by 1978.) But, and this is a statistic I mentioned earlier, the number of entering students to these programs remained at an average of 10/year and the continuing sophomores remained at 4/year. Again, the industry was forced to resurrect their in-house programs to provide the personnel.

This brings us to the present. The need for technicians is not only still with us but the demand is increasing. We must also realize that the kinds of tasks required of these people are as varied and sophisticated as they are for the chemists and chemical engineers with whom they work.

There are a number of routes that can be followed to help fill this national need. As I mentioned earlier, I am convinced that a liberal education coupled with a strong committment to the special approach to the kind of chemistry coursework necessary is that as maintained in the comprehensive two-year college setting. (Because of time limitation the alternatives to this approach will not be discussed.)

A two-year college system contemplating starting a new chemical technology program or one that has a program already in place, but of minimal success) should institute a self-evaluation scheme to look at its ability to institute or upgrade

such a program. Guidelines for such an evaluation can be developed locally or be attained through the ACS office of two-year college education. Once the guideline criteria hve been met, the local 2YC should, within state and regional accreditation regulations, implement a reasonable scheme to include:

1) A student recruitment program (INPUT)
2) Curriculum (Instituting MCT) (Fig. 3)
3) A student placement program (OUTPUT)

(points 1 and 3 also may be coordinated through a centralized college function using a faculty liaison.)

It is suggested that the above three components would best be maintained by the chemistry (chemistry technology) faculty with a person from that group to be designated as coordinator of chemical technology. This position, once the program is in place and functioning, should be ongoing so as to maintain the high program quality necessary to meet academic and industrial standards.

It must be emphasized very strongly at this point that the following parameters be met to form a strong link between students, the program and the chemical industry.

1) Establish the position of a "Coordinator of Chemical Technology". The duties of this position may include:

(Fig. 4) a) <u>recruitment of students</u> (this may be a joint venture with the admissions office of the College)

b) <u>establish an academic advisement procedure</u> to be followed by faculty and students.

c) <u>institute an advisory committee on chemical technology</u>

1) Make-up of the committee should include:
A working chemist, a working technician, a human relations person representing the industry, a member of the College administration, a student and a faculty member. (These are minimum suggestions.)

2) This committee may participate in:
·suggesting new methods used in industry
·job opportunities for chem techs
·helping formulate field trips for current students
·suggesting a speakers bureau for the college, and possible for recruiting students to the program

·helping attain high cost instrumentation (as loan or outright gift)
·set-up a temporary exchange program between academic professors and working chemists

(The above are a few suggestions that directly effect the performance of students in the program, therefore will help in retainment.)

d) intersect with the department chairperson on not only curricula affairs for the program but also on budgeting conditions (It should be stressed that a separate budget for Chem Tech would be advisable - special chemicals and equipment use is an absolute necessity)

e) Coordinate curricula activities for the program. Reflect not only on industrial needs but also student insights regarding the daily program activities. Student concerns must be met for retaining of same.

f) Coordinate the direct placement of students into industrial positions. (part-time during matriculation and full-time upon graduation)

1) Setting up of cooperative program is very desirable and should be the function of the coordinator.

(The above mentioned coordination activities are a suggested number of duties that are seen as critical to the maintaining the quality of a chemical technology program.)

(Fig. 5) This next figure illustrates the alternatives that are open to the persons that pursue the chemical technology program route to their chemistry career.

Starting at "A", a student's main course of studies will allow for a "regular track" matriculation. This leads to immediate employment. At this point "B" a decision may be made to: 1) go on to further education or to, 2) remain on the job as a technician. If the decision is to further ones education towards the baccalaureate it may be accomplished on a part-time (usually employer will underwrite part or all education costs) on a full-time basis. At any rate (if necessary), math, physics, and other requirements demanded by B.S. matriculation requirements must be met.

Another alternative, the AAS degree person could exercise (with proper advisement) will be direct entry to a B.S. program. (Approximately 10% of the CCRI

chem. tech. students opt direct entrance to B.S. programs. The number is a low one - but remember, Chem Tech Programs focus in on producing technicians not chemists. These options must be available to all. Education should never be considered terminal at any level.) Then as the traditional progression allows, one may decide on employment, or graduate school and then employment. We see that the options open to the matriculating student after the attainment of the AAS is not only available but because of a period of real industrial employment, a realistic decision can be made for their future.

A mention of two recent happenings that will hopefully bring about positive influences on the establishing of chemical technology and other comprehensive chemistry programs of high quality.

1) Recommendations of task force for The Study of Chemistry Education. The name of the report is "TOMORROW", Available through ACS. These recommendations addressed science (chemistry) education from grade K through graduate school including two year college chemistry programs (including Chemical Technology).

2) The formation of a task force through the Society Committee on Chemical Education to restructure the 1970 guidelines for chemistry programs in the two year college to reflect modern chemistry demands. (now being undertaken)

An immediate goal of this task force is and I quote from "TOMORROW"s recommendation T 3

> "When the Revised Guidelines have been published and the outreach and consultation program is functioning, the American Chemical Society should undertake to certify/approve chemical technology programs in two year colleges at the request of such institutions."

This certification/approval mechanism is yet to be addressed but it is my hope that it will be soon in place and functioning to produce high quality programs.

(Fig. 1)

HISTORICAL DEVELOPMENT OF TECHNICIAN PROGRAMS

1840's

1st Tech Training Programs (Lowell Textile)

1917-18

Training Sites for U.S. Army Tech. Personnel

Formal Chem-Tech. Program 1920

(Ohio Mechanics Inst.)

(Industrial Demands for Tech's)

[Most Techs from Industry.]

1940's-50's

Tech Institutes Start-Up

Chem. Industry In-House Programs

Late 1950's Demands Bring Some Comprehensive Two Year Colleges in-----

[Most Techs from Industry.]

1960's----------1980's

'62 Voc. Ed. Act. $'s (more Two Year Institutions)

'64 - Young Committee

'66 - Roberts Committee

'70 ChemTeC Project

[(These Efforts-- 200 colleges (numbers up)]

About 1976-77 numbers of colleges dropped (low enrollment)

[·1980--PRESENT-- Industry again]

Fig - 2

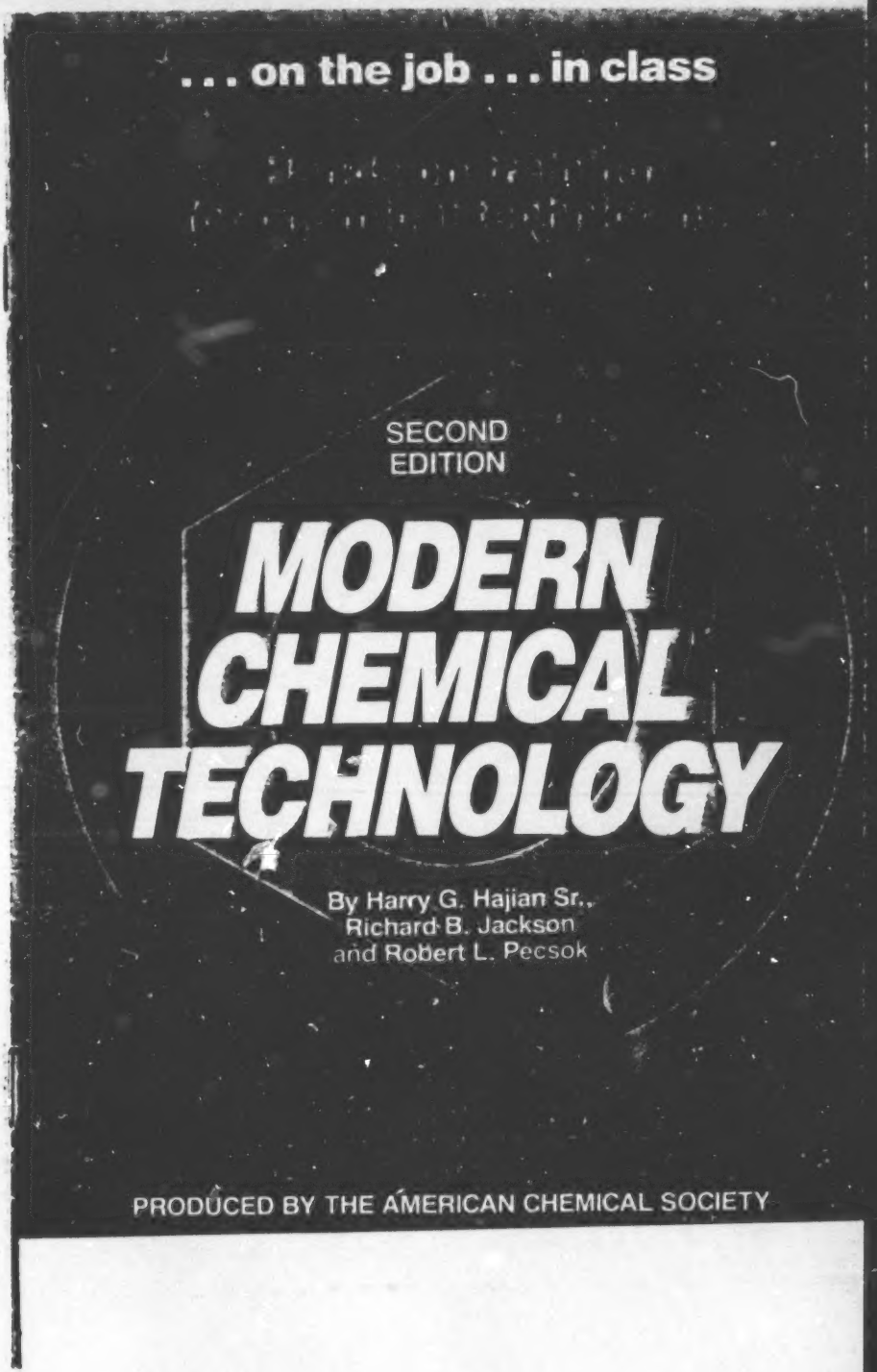
. . . on the job . . . in class
SECOND
EDITION
MODERN
CHEMICAL
TECHNOLOGY
By Harry G. Hajian Sr.,
Richard B. Jackson
and Robert L. Pecsok
PRODUCED BY THE AMERICAN CHEMICAL SOCIETY

FIG-2

Volume 1

THINGS AROUND US

Pure Substances and Mixtures, Importance of Composition, What Chemists Mean by Analysis, Another Definition of Purity, Metric System Simplifies Work

MORE ABOUT SEPARATION

The Gas Chromatograph, Separation in a GC Column, The Key to GC, A Typical Gas Chromatograph, Graphs, Interpretation of a Gas Chromatogram, Injection and the Air Peak, Separation of Air and Benzene, A Note About Units, Comparison of Two Benzene Chromatograms, Retention Time, Peak Heights, Separation of a Mixture of Acetone and Benzene by GC, Need for a Notebook, Rules for Your Notebook

MEASURING MASS, WEIGHT, AND DENSITY

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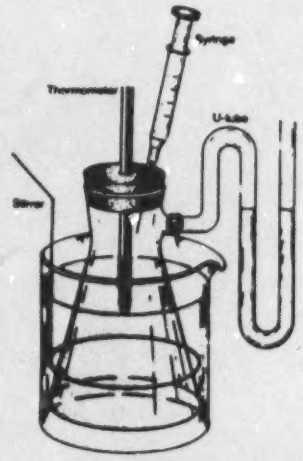

ELEMENTS AND COMPOUNDS

The Atom, Elements, Symbols of Elements, Atomic Weights, The Periodic Table, Metallic Elements, Nonmetallic Elements, Formation of Molecules, The Metalloids, Molecular Formulas, Molecular Weights, Elements as Pure Substances, Compounds as Pure Substances, Compounds and Definite Composition, Definite Composition and Reactions, Chemical Reactions, Decomposition Reactions, Weighing by Difference, Error in Weighing Due to Air Convection, Desiccators, Arrangement of Atoms in Compounds, Molecular Compounds, Nonmolecular Compounds, Formulas of Compounds, Formula and Molecular Weights, Percentage Composition of Compounds, More About Relative Weights, The Mole Concept, Using the Mole Concept in Problems

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Volume 2

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EQUILIBRIUM

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EQUILIBRIUM IN AQUEOUS SOLUTIONS

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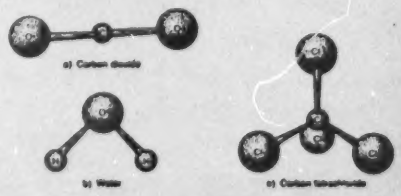

Volume 3

INTRODUCTION TO ANALYSIS

The Value of an Analysis, The Steps of an Analysis, Limits of Detection in ppm Units, Specific vs Selective Tests, Acids Used for Dissolutions, Water in Samples, Removal of Nonessential Water, Sampling of Gases, Sampling for Particulates, Sampling for Gases in Air, Absorption, Adsorption, Freeze-out or Condensation, Grab Sampling

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ATOMIC ABSORPTION SPECTROPHOTOMETRY

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AMINO ACIDS AND PROTEINS

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OTHER NATURAL PRODUCTS

Fats and Oils, Reactions and Uses of Fats, Saponification, Ester Exchange Reactions, Drying of Oils, Paints, Waxes, Steroids, Alkaloids, Terpenes

SYNTHETIC POLYMERS

Molecular Weight Distribution, Molecular Weight Determination, Physical Properties of Polymers, The Effect of Structure on T_g, Addition Polymers, Chain-Branching and Cross-Linking, Copolymerization, Cationic and Anionic Polymerization, Diene Polymerization — Rubber, Types of Commercially Important Addition Polymers, Plasticizers and Other Additives, Condensation Polymers, Polyamides, Polyesters, Phenol-Formaldehyde Polymers, Silicones, Miscellaneous Types

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LIQUID COLUMN CHROMATOGRAPHY

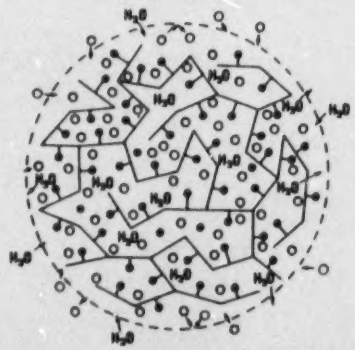
LSC, Packing Columns, Gradient Elution, LLC, Choice of Phases, Bonded-Phase Chromatography (BPC), Packing a High Performance Column, Ion Exchange, Labeling of Ion Exchange Resins, Preparing an Ion Exchange Column, Extent of Ion Exchange, Complex and Chelate Resins, Ion Retardation Resins, Gel Chromatography, Experimental Technique, Materials for Gel Chromatrography, Gel Permeation Chromatography

GAS CHROMATROGRAPHY

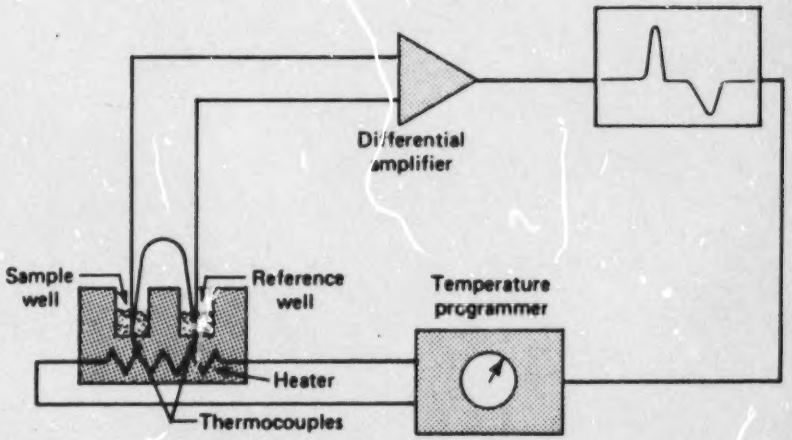
Solid Supports, Solid Adsorbents, Liquid Phases, Column Conditioning, Detectors, Information from the Chromatogram, Relative Retention Time, Peak Integration, Temperature Programming, Applications of Gas Chromatography, Space Probes

PAPER AND THIN LAYER CHROMATOGRAPHY

Techniques, Thin Layer Chromatography, Adsorbents and Solvents, Chemical Constitution and Adsorption Chromatography, Quantitative Analysis, Other Separation Methods, Electrophoresis, Mobility, General Technique, Continuous Electrophoresis, Dialysis



Volume 6



AUTOMATION AND PROCESS CONTROL

Automatic Elemental Analyzers, Basic Automatic Analyzer, Dupont "ACA," Technicon "Autoanalyzer," The "GeMSAEC" System, Process Analyzers, Feedback Control, Feedforward Control

NUCLEAR CHEMISTRY AND THE MEASUREMENT OF RADIOACTIVITY

Radioactivity, Nature and Properties of Radiation, Contrast Between Chemical and Nuclear Reactions, Nuclear Structure, Nuclear Reactions, Natural Radioactive Decay Chains, Transuranium Elements, Nuclear Bombardments, Ion Bombardments, Uses of Radionuclides, CAT-Scanners, Radiation Hazards, Nuclear Fission, Fission Products, Nuclear Fusion, Activity of a Sample, Decay Rate of a Radionuclide, Ionizing Radiation, Radiation Detectors, Geometry, Background, Statistics, Radiochemical Separations

THERMAL METHODS OF ANALYSIS

Pyrolysis, Thermal Stability Tests, Calorimetry, Differential Thermal Analysis, Thermocouples, Differential Scanning Calorimetry, Measurement of Specific Heat by DSC, Thermogravimetric Analysis, Thermomechanical Analysis, Multiple Thermal Analysis

NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY

Theory of NMR Spectroscopy, The Chemical Significance of NMR Spectra, An NMR Spectrum, Chemical Shifts, NMR Correlation Charts, Some Examples of NMR Spectra of Known Molecules, Coupling Constant, Putting It All Together

OBTAINING NMR SPECTRA

The NMR Instrument, Solvents and Sample Preparation

MASS SPECTROMETRY

Cathode Rays, Canal Rays, Simple Mass Spectrometer, Laboratory Mass Spectrometers, Time of Flight Mass Spectrometer, Quadrupole Mass Spectrometer, Applications of Mass Spectroscopy, Isotopic and Fragmentation Patterns, High Resolution Mass Spectroscopy

(Fig. 3)

A TYPICAL CHEMICAL TECHNOLOGY PROGRAM

(USING THE ACS MCT SERIES)

Chemical Technology

The chemical industry is one of the fastest growing industries in the United States. Its need for trained technicians in quality control, analysis, and research and development laboratories is extensive. The two-year Chemical Technology Program prepares the student to enter the chemical field in any one of a variety of capacities: chemical research technician, laboratory assistant, chemical production technician, junior chemist or analytical technician. The program is structured to develop a fundamental understanding of general, organic and analytical chemistry, with emphasis on laboratory applications and techniques. Consistent with the program's philosophy of unifying practice and theory, lecture and laboratory hours are not specified independently.

Program Requirements

Course No.	Course Title	Class	Lab	Credit
First Semester				
450-170	Algebra for Technology	4	0	3
160-104	General Biology II	3	2	4
901-112	Chemical Technology I	2	8	6
	Elective: humanities or social sciences	3	0	3
		12	10	16
Second Semester				
450-171	Trig for Technology	4	0	3
600-112	Modern Technical Physics I	3	2	4
901-122	Chemical Technology II	2	8	6
280-101	Composition I	3	0	3
		12	10	16
Second Year				
First Semester				
901-232	Chemical Technology III	4	12	10
600-122	Modern Technical Physics II	3	2	4
903-100	Intro. to Microcomputers	3	3	3
		10	17	17
Second Semester				
901-242	Chemical Technology IV	4	8	8
160-248	General Microbiology	2	4	4
	Elective: humanities or social sciences	3	0	3
		9	12	15

COURSE DESCRIPTIONS

Chemical Technology

Also see Chemistry

901-112 – Chemical Technology *6 Credits* An introduction to basic concepts in chemistry. The chemical properties, identification, and separation of substances; atomic and molecular structure; elements and compounds; liquids and solutions; the periodic table; and the naming of inorganic compounds are studied. The student is instructed in the use of a variety of instruments including the gas chromatograph, manometers, analytical balances, and visible spectrophotometers.
Lecture: 2 hours Lab: 8 hours

901-122 – Chemical Technology II *6 Credits* A continuation of Chemical Technology I. The areas covered include acid-base chemistry, equilibrium, qualitative and quantitative analysis.
(Prerequisite: 901-112 or its equivalent)
Lecture: 2 hours Lab: 8 hours

901-232 – Chemical Technology III *12 Credits* A continuation of Chemical Technology II. The areas covered include an introduction to organic chemistry via functional group of organic compounds, classification of organic compounds using wet and instrumental methods, and organic reactions. Infrared spectrophotometry, gas chromotography, and distillation techniques are stressed.
(Prerequisite: 901-122 or its equivalent)
Lecture: 6 hours Lab: 12 hours

901-242 – Chemical Technology IV *12 Credits* A continuation of Chemical Technology III. Topics covered include the nature of reversible processes, equilibrium constants, solute and solvent systems and the kinetics of chemical reactions. Instrumental methods include atomic absorption, emission spectroscopy, ultraviolet and nmr spectophotometry. The course concludes with a variety of special methods and student projects.
(Prerequisite: 901-232 or its equivalent)
Lecture: 6 hours Lab: 12 hours

(Fig. 4)

Chemical Reactions in YOUR Future!

ASSOCIATE IN APPLIED SCIENCE DEGREE
CHEMICAL TECHNOLOGY PROGRAM
COMMUNITY COLLEGE OF RHODE ISLAND

LOOK AT YOUR IMMEDIATE EMPLOYMENT OPPORTUNITIES

QUALITY CONTROL TECHNICIAN

Routine tests of materials, products, and processes to ensure they meet manufacturer's specifications and quality control standards.

$11,000 - $13,000

ANALYTICAL TECHNICIAN

Non-routine tests of new products and processes involving development of new techniques.

$12,000 - $14,000

RESEARCH AND DEVELOPMENT TECHNICIAN

Conduct tests, measure reactions, analyze data, and record results of experiments.

$13,000 - $18,000

MEANWHILE....., FURTHER YOUR EDUCATION....., EITHER AFTER GRADUATION OR WHILE ON THE JOB!!

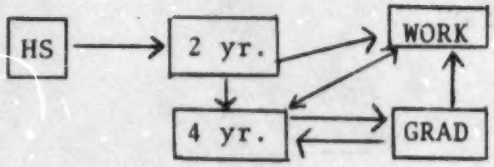
TRANSFER YOUR ASSOCIATE IN APPLIED SCIENCE DEGREE IN CHEMICAL TECHNOLOGY TO A FOUR YEAR BACHELOR OF SCIENCE OR BACHELOR OF ARTS DEGREE PROGRAM IN CHEMISTRY!!

RESULT: EMPLOYMENT STARTING AT $17,000 - $22,000!!!!!

JOB OUTLOOK: FAVORABLE THROUGH THE 80's
GROWTH RATE FASTER THAN THE AVERAGE FOR ALL OCCUPATIONS

BEST OPPORTUNITIES FOR GRADUATES OF POST-SECONDARY TECHNICAL TRAINING PROGRAMS!!!!!

(Fig. 5)



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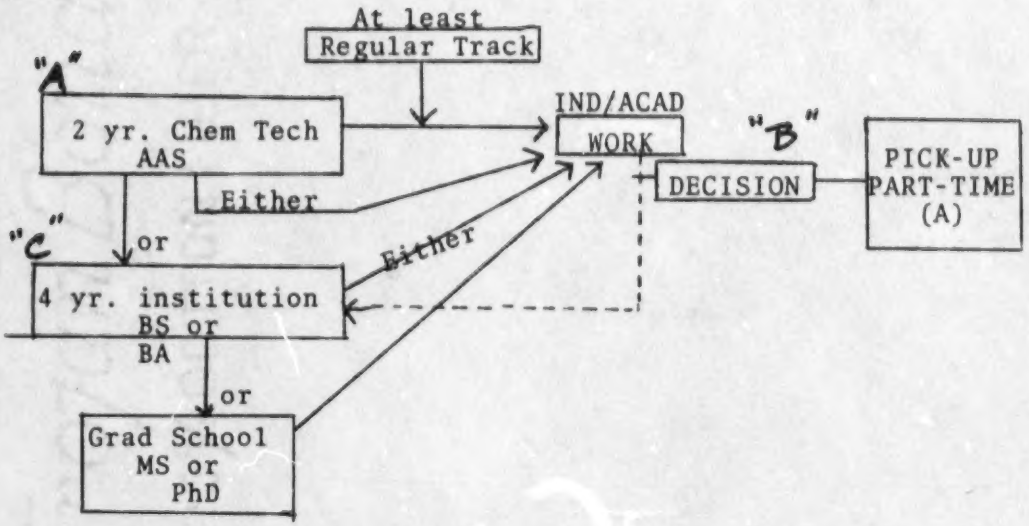

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PLUS (A)

1. Advanced Math
2. Advanced Physics
3. Proper Electives
4. More in Depth Theory in Chem

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